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A HORNET, PAPER WASPS, AND YELLOWJACKETS (HYMENOPTERA: VESPIDAE) IN SUBURBAN HABITATS OF THE WASHINGTON, D.C., AREA

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Abstract.—Based on Malaise trap catches made in five suburban habitats during 1980 to 1984, 1 hornet (*Vespa*), 2 paper-wasp (*Polistes*), and 9 yellowjacket (*Dolichovespula, Vespula*) species were found in the Washington, D.C., area: *Dolichovespula arenaria, D. maculata, Polistes exclamans, P. fuscatus, Vespa crabro, Vespula acadica, V. flavopilosa, V. germanica, V. maculifrons, V. squamosa, V. vidua,* and *V. vulgaris. Vespula maculifrons* was the most frequently captured species. *Vespula acadica* has not been previously reported in the study area. Traps were used for 2 to 5 years in each location, and they each caught eight to 10 species. Their catches were often significantly correlated with regard to species and species abundances; nonetheless, cases of no correlation suggest marked catch differences among traps. Walk counts and Malaise trap counts made in the same habitat during the same week often produced different indications of species composition and abundances.

This study has three aims. First, it reports the species of paper wasps (*Polistes*), yellowjackets (*Dolichovespula, Vespula*), and hornet (*Vespa*) found, their relative abundances, and their flight times in five suburban habitats in the Washington, D.C., area. Four of the habitats were in Maryland: a highly disturbed yard garden, a wooded-stream habitat, a periodically mowed field, and the ecotone between the wooded-stream habitat and a lawn. The fifth site was a residential yard in Virginia. The study data were obtained from Malaise traps. Second, this investigation describes how catches differ among the traps. Last, it compares wasp abundance determinations based on contemporaneous walk counts with Malaise-trap catches in the yard garden.

Paper wasps, yellowjackets, and hornets are primitively eusocial wasps that are often common in temperate, suburban habitats. These wasps are beneficial predators that consume pestiferous insects, such as lepidopterans that eat crops, and, thus, have been studied as possible biocontrol agents in the U.S. (Gillaspy, 1977; Gould and Jeanne, 1984). Further, they scavenge wastes, and thereby help to recycle environmental resources. However, these wasps are often considered to be pests because they have potent stings and nest near, on, or in houses and other buildings; and some species are nuisances when they are attracted to food at picnics, in garbage cans, and other places (Davis, 1978; Akre et al., 1981; pers. obs.).

In North America, previous investigators have studied many aspects of the

biologies of these wasps (Akre et al., 1981). For example, Matthews (1982) investigated seasonal abundances of queens of *Vespula maculifrons* and *V. squamosa* based on walk and Malaise-trap counts in three Georgia suburban habitats. Roush and Akre (1978) used heptyl-butyrate traps and Malaise traps to study seasonal abundances of *Dolichovespula* and *Vespula* in Oregon. However, the seasonal cycles and flight periods of the paper wasps, yellowjackets, and hornet have not been previously elucidated in the Washington, D.C., area.

In this area, I found that six Malaise traps used from April to mid-November 1980–1984, collected 12 species of these wasps. All traps obtained similar numbers of species, but species abundances were significantly correlated between only some of the traps. Walk counts were often uncorrelated with contemporaneous trap counts from the same habitat.

Materials and Methods

This study used five Cornell-style and one Townes-style Malaise traps. The pyramidal, 2-m-tall Cornell traps are made of white gauze and aluminum-pipe supports. The bases of the traps are 1.2 × 1.2 m, and each of their four sides has a rectangular arthropod-catching opening of 0.8-m^2 that extends from the ground to 70 cm above it. David R. Smith, who donated data to my study, trapped wasps using the Townes trap, which has two black-gauze, 1.8-m^2, rectangular catching surfaces extending from the ground to 1.1 m above it. The remainder of the gauze of his trap is white.

All traps were left up 24 h per day from 1 April to mid-November. Wasp species and their abundances were determined from catches obtained from 1 April to 31 October. Late flight times were obtained from the November catches. Captured insects were removed from traps approximately once per week.

All traps were within 15 km of Washington, D.C. Smith trapped wasps in the yard of his residence near Annandale, Fairfax County, Virginia. His trap was shaded by *Acer saccharinum* L., *Pinus strobus* L., and *Malus* sp.

I used two Cornell traps in my yard garden in Glen Echo, Maryland, and one in a wooded-stream habitat, field, and the ecotone between the wooded-stream habitat and a lawn in the David W. Taylor Naval Ship Research Center, 5 km NNW of Glen Echo. I chose this Center because it was a safe place where I could trap wasps in habitats that are more natural than suburban yards. The Center is fenced and guarded 24 h per day. In past work, three of my traps in unprotected sites were cut up, torn, or both by vandals.

In the yard garden, I placed one trap (the south trap) 0.3 m from the southwest corner of my house from 1982 to 1984 and a second trap (the north trap) 1 m from the northeast corner of my house from 1980 to 1984. The south trap was unshaded by trees or houses, while the north trap was usually in shade from houses, *Acer negundo* L. and *Pinus strobus*. I regularly watered my yard garden during dry spells making it one of the moister and floriferous areas in Glen Echo. It attracted wasps because it usually contained flowers that they used as nectar sources, including *Asclepias curassavica* L., *Celosea argentea* L., *Helianthus* cvs., *Impatiens balsamina* L., and *Pastinaca sativa* L., and during dry spells, wasps drank from water droplets on plants. Nests of *Polistes exclamans* and *Dolichovespula maculifrons* occasionally occurred in my yard garden.

At the Taylor Research Center, the wooded-stream habitat contained large trees

including *Quercus* spp., *Liriodendron tulipifera* L., and *Platanus occidentalis* L. The ecotone was an irregular edge of this woods and a 1-m-wide strip of low brush that ran east and west and was bordered by lawn on its south side. The ecotone trap was placed near a lawn instead of next to the field because there was no available east-west edge of the woods adjacent to the field. The ecotone trap was in direct sunlight during afternoons and the field trap was in direct sunlight all day. Grasses dominated the field which was mowed once in 1983 (September) and once in 1984 (June).

Cornell trap catches were reduced by certain arthropod activities within the traps including the following. Carpenter bees (*Xylocopa virginica* L.) periodically bit holes in their gauzes just below their collecting heads, and they, as well as other arthropods, escaped through the holes until I repaired them with silicone glue and gauze patches. I saw a few carpenter bees and bumble bees crawl down trap sides and escape through usual openings. Occasional spiders and praying mantids perched inside traps just below collecting heads where they consumed ample prey until I found these predators and removed them. Finally, large butterflies, which did not crawl into the funnel of the catching head, remained just below it until I removed them or they fell to the ground dead or in feeble states.

Contemporaneous trap catches and walk censuses were made in July–August, 1983. I made one walk count per day between 11 a.m. and 5 p.m., 3–7 days per week.

Possible correlations in the numbers of individuals of the 12 captured wasp species between traps were analyzed using the Spearman-rank-correlation-coefficient program of the SAS computer package (Ray 1982a, b). Voucher specimens were deposited in the U.S. National Museum (U.S.N.M.).

Results and Discussion

Species richness and relative abundances.—The 12 species of captured wasps and their feeding behaviors (based on Barrows, 1979, pers. obs.; Akre et al., 1981; MacDonald and Matthews, 1984) are: *Dolichovespula arenaria* (Fabricius), predator, carrion scavenger; *D. maculata* (L.), predator, protein scavenger; *Polistes exclamans* Viereck, predator, nectar forager; *P. fuscatus* (Fabricius), predator, nectar and honey-dew forager; *Vespa crabro* L., predator, plant-sap forager; *V. acadica* (Sladen), predator; *V. flavopilosa* Jacobson, feeding behavior unknown; *V. germanica* (Fabricius), predator, protein scavenger and sugar forager; *V. maculifrons* (Buysson), predator, scavenger; *Vespula squamosa* (Drury), social parasitism of host's food, protein scavenger; *V. vidua* (Saussure), predator?; and *V. vulgaris* (L.), predator, protein scavenger and sugar forager. "Predator" indicates being a predator of insects.

The numbers of individuals of each species collected are listed in Table 1. Counts for each wasp species are the total numbers of queens, workers, and males obtained in all 5 yr of the study. Traps collected similar numbers (8–10) of wasp species even though two kinds of traps were used, and trap locations were so different. The field trap collected the largest annual number of wasps, followed, in decreasing order, by the yard-garden south trap, yard trap, ecotone trap, yard-garden north trap, and wooded-stream-habitat trap.

Vespula maculifrons was the most frequently obtained species, followed in decreasing order by *Polistes fuscatus, Dolichovespula maculata, Polistes excla-*

Table 1. Numbers of wasps of each species collected in suburban habitats. Wasps: DA, *Dolichovespula arenaria*; DM, *D. maculata*; PE, *Polistes exclamans*; PF, *P. fuscatus*; VA, *Vespula acadica*; VC, *Vespa crabro*; VF, *Vespula flavopilosa*; VG, *V. germanica*; VM, *V. maculifrons*; VS, *V. squamosa*; VV, *V. vidua*; VVu, *V. vulgaris*. Traps: ET, ecotone; FT, field; YGNT, yard-garden north; YGST, yard-garden south; YT, yard; WSHT, wooded-stream-habitat. N, number of species taken by a particular trap; WPY, mean number of wasps collected per trap per year.

Trap and Years	Species													
	DA	DM	PE	PF	VA	VC	VF	VG	VM	VS	VV	VVu	N	WPY
YGNT 1980–1984	2	2	31	219	0	0	0	2	145	1	2	1	9	81
YGST 1982–1984	1	3	23	147	0	5	0	6	100	1	0	0	8	95
YT 1982–1984	6	35	0	59	0	1	3	2	149	0	1	2	9	86
WSHT 1983–1984	20	8	0	2	0	5	0	2	42	1	5	3	9	44
ET 1983–1984	11	25	0	58	1	8	0	1	53	0	0	10	8	84
FT 1983–1984	5	7	3	77	0	3	0	1	121	1	1	2	10	111
Total	45	80	57	562	1	22	3	14	610	4	9	18	—	—
Abundance Rank	5	3	4	2	12	6	11	8	1	10	9	7	—	—

mans, Dolichovespula arenaria, Vespa crabro, Vespula vulgaris, V. germanica, V. vidua, V. squamosa, V. flavopilosa, and *V. acadica*. The ecotone trap collected one worker of *Vespula acadica,* a species not previously found in the Washington, D.C., area according to a distribution map in Akre et al. (1981). Maps in this reference also suggest that *Dolichovespula arctica* and *Vespula consobrina* occur in the Washington, D.C., area; however, the traps did not obtain them. Further, I did not find any specimens of any of these three species and *V. flavopilosa* from the Washington, D.C., area in the U.S.N.M. collection. Although specimens for *Polistes annularis* from this area were found in the U.S.N.M. collection, none were collected by the traps. However, they did obtain all species of *Vespula, Vespa,* and *Dolichovespula* found in the U.S.N.M. collection for the Washington, D.C., area.

Comparisons of trap catches.—Fifteen correlation analyses of the number of individuals of each of the 12 species collected by individual traps were performed (Table 2). The field trap was positively correlated with all other traps; the ecotone trap catch was correlated with all traps except the yard-garden ones; the yard-garden traps were correlated with each other and the field trap; the wooded-stream-habitat trap was correlated with all but the yard-garden traps; and the yard trap was correlated with all but the yard-garden traps. Thus, the data suggest that the field trap collected a species group with relative abundances intermediate between those of yard-garden traps and the rest of the traps.

Flight times.—Flight periods of wasps are listed in Table 3. When queens could

Table 2. Significance levels (Ps) of Spearman-rank correlation coefficients resulting from comparisons of the number of individuals in each of 12 species caught by each of six traps during all years that it was used. The abbreviations for traps are the same as those used in Table 1. Nonsignificant Ps ($P > 0.05$) are enclosed by parentheses.

	FT	WSHT	YGNT	YGST	YT
ET	0.0017	0.0268	(0.1327)	(0.1022)	0.0023
FT		0.0149	0.0071	0.0064	0.0172
WSHT			(0.2669)	(0.5034)	0.0329
YGNT				0.0067	(0.0957)
YGST					(0.2065)

be easily distinguished by their large sizes compared to workers, flight seasons of both queens and workers are listed separately. Matthews (1982) reported flight times for queens of *V. maculifrons* and *V. squamosa,* based on Malaise-trap and horse-fly trap catches in Athens, Georgia, that are earlier than the ones that I found, possibly a result of an earlier spring in Athens. Based on heptyl-butyrate and modified-Malaise-trap counts in 1977 in Oregon, Roush and Akre (1978) found the first workers of species, common to both Oregon and the Washington, D.C., area, on dates similar to mine: *D. arenaria,* 5 June; *D. maculata,* 7 July; and *V. vulgaris,* 6 July.

Walk vs. Malaise-trap censuses.—Comparisons of walk and Malaise-trap censuses in the yard garden (Table 4) indicate that these methods yield markedly

Table 3. Flight times of collected wasps from all years and traps combined. The years in which the earliest, latest specimens, or only specimens were trapped are given in parentheses.

Species	Flight Periods
Dolichovespula arenaria	males, 15 July–30 September (1984); workers, 12 June (1983)–4 November (1984)
D. maculata	males, 5 November (1981); queens, 14–31 May (1984), 11–15 October (1984); workers, 8 July–11 September (1983)
Polistes exclamans	females, 8 April (1984)–21 August (1983)
P. fuscatus	females, 4 April (1981)–1 November (1983)
Vespa crabro	queens, 15 May (1983), 7 August–2 October (1983); workers, 3 July (1983)–25 October (1984)
Vespula acadica	worker, 21 August (1983)
V. flavopilosa	male, 30 September (1984); workers, 5 August–4 November (1984)
V. germanica	queens, 20 April–6 May (1982), 1 November (1983); workers, 25 July (1982)–21 October (1981)
V. maculifrons	males, 21 October–5 November (1981); queens, 9 April (1981)–26 June (1983); workers, 17 June (1981)–9 November (1980)
V. squamosa	queens, 31 May–20 June (1984); workers, 7 August–21 August (1983)
V. vidua	queens, 14 May–12 June (1984); workers, 12 July (1984)
V. vulgaris	males, 21 August (1983); queens, 24 April (1980)–24 July (1983); workers, 15 July (1984)–2 October (1983)

Table 4. Per-day counts of wasps from walk censuses and trap censuses made in the yard garden in 1983. For each week, the number of days on which I made walk censuses is indicated in parentheses. T, trap census; W, walk census.

	Weeks									
	July		August						September	
	25–31 (4)		1–7 (4)		8–14 (3)		15–21 (7)		5–11 (3)	
Species	T	W	T	W	T	W	T	W	T	W
Dolichovespula maculata	0.3	0.5	0.4	0.3	0	0.3	0	0.6	0	0
Polistes exclamans	0.3	2.0	0.1	1.0	0.1	1.0	0.3	0.1	0	0.3
P. fuscatus	1.6	7.0	1.3	5.3	0.3	4.3	0.4	2.4	0	1.3
Vespa crabro	0	0	0.3	0	0	0	0	0	0	0
Vespula germanica	0	0	0	0	0	0	0.1	0	0	0
V. maculifrons	0.3	0.3	0.1	0	0.6	0	0.4	0.3	0	0
V. squamosa	0	0	0.1	0	0	0	0.4	0.1	0	0
V. vulgaris	0	0	0	0	0	0	0	0.1	0	0

different results when simultaneously used to sample wasps. Walk censuses found five species that the trap did not collect during the same weeks, but trap censuses found five species that the walk censuses did not reveal, and in 22 of the 40 comparisons, walk and trap censuses were not identical. Nonetheless, one type of sampling alone is likely to give a reasonable indication of relative population size changes of particular species that it commonly censuses (Roush and Akre, 1978). Because no species of wasps in the studied genera were seen during any walk censuses in the yard garden that were not caught by the traps, the traps alone were an adequate means of sampling species richness of these genera.

The type and location of a Malaise trap affects what species and how many of them that it catches (Matthews and Matthews, 1970). In my study, even two close-by traps in the yard garden caught markedly different numbers of some species, and they even caught different species (Table 1). Matthews and Matthews (1970) indicate that Townes traps catch many more arthropods than Cornell traps. Nonetheless, in my study, the Townes trap caught only the third-highest number of wasps, and it did not collect the largest number of species. This might be due to its location, which was shaded and not immediately adjacent to many nectariferous flowers for much of the flight season, rather than its catching ability.

In conclusion, the Malaise traps caught 12 vespid species in *Dolichovespula, Polistes, Vespa,* and *Vespula* in five suburban-area habitats. During 5 years, hundreds of wasps were obtained, with trap designs and locations evidently affecting the numbers of individuals of the different species that were captured. Because contemporaneous walk censuses and trap captures gave different indications of the numbers and abundances of species, a combination of sampling methods is probably needed to give a complete picture of vespid-wasp community structure of a sampled region.

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Literature Cited

Akre, R. D., A. Greene, J. F. MacDonald, P. J. Landolt, and H. G. Davis. 1981. The yellowjackets of America north of Mexico. U.S. Dept. Agric. Agric. Handb. No. 552. 102 pp.

Barrows, E. M. 1979. *Polistes* wasps (Vespidae) show interference competition with other insects for *Kermes* scale insect (Kermesidae) secretions. Proc. Entomol. Soc. Wash. 81: 570–575.

Davis, H. G. 1978. Yellowjacket wasps in urban environments, pp. 163–185. *In* G. W. Frankie and C. S. Koehler, eds., Perspectives in urban entomology. Academic Press, N.Y. 417 pp.

Gillaspy, J. E. 1977. Management of *Polistes* wasps for caterpillar predation. Southwest. Entomol. 4: 334–352.

Gould, W. P. and R. L. Jeanne. 1984. *Polistes* wasps (Hymenoptera: Vespidae) as control agents for lepidopterous cabbage pests. Environ. Entomol. 13: 150–156.

MacDonald, J. F. and R. W. Matthews. 1984. Nesting biology of the southern yellowjacket, *Vespula squamosa* (Hymenoptera: Vespidae): Social parasitism and independent founding. J. Kans. Entomol. Soc. 57: 134–151.

Matthews, R. W. 1982. Social parasitism in yellowjackets, pp. 193–202. *In* P. Jaisson, ed., Social insects in the tropics, Vol. I., Univ. Paris, Nortd.

Matthews, R. W. and J. R. Matthews. 1970. Malaise trap studies of flying insects in a New York mesic forest. Ordinal composition and seasonal abundance. J. N.Y. Entomol. Soc. 78: 52–59.

Ray, A. A., ed. 1982a. SAS user's guide, basics, 1982 Edition. SAS Institute, Inc., Cary, N.C. 923 pp.

———. 1982b. SAS user's guide, statistics, 1982 Edition. SAS Institute, Inc., Cary, N.C. 584 pp.

Roush, C. F. and R. D. Akre. 1978. Nesting biologies and seasonal occurrence of yellowjackets in northeastern Oregon forests (Hymenoptera: Vespidae). Melanderia 30: 57–94.